Desired Technical Aspects of the SAS System

Presented by the Wireless Internet Service Providers Association
January 3, 2014

GN Docket No. 12-354

Introduction

The Wireless Internet Service Providers Association (WISPA) commends the Federal Communications Commission (FCC) for proposing the use of an intelligent three-tiered Spectrum Access System (SAS) to enable Incumbent Access, Priority Access (PA) and opportunistic General Authorized Access (GAA) to spectrum in the 3550-3650 MHz band. WISPA believes that the use of a robust, automated online database that incorporates dynamic frequency assignment capability represents a significant step forward in the development of spectrum management technology that can enable and enforce spectrum access that will promote spectral efficiency, consumer welfare and economic growth. Further, WISPA believes that successful SAS deployment in the 3550-3650 MHz band will demonstrate the value of database-enabled spectrum management that will lead the way to similar opportunities in other frequency bands.

This paper discusses selected technical aspects of the proposed SAS for the 3.5 GHz band in response to the FCC's November 18, 2013 Call for Papers.[1] In this proceeding (GN Docket No. 12-354), WISPA has filed Comments and Reply Comments supporting the proposed three-tiered SAS database that builds on TV White Space (TVWS) database concepts but potentially offers additional, more advanced capabilities. It is our hope that this discussion will assist in the further development and implementation of a secure SAS that maximizes spectral efficiency in the 3550-3650 MHz range. WISPA's primary interest is in gaining access to spectrum that can deliver higher-power signals for fixed wireless broadband services in rural areas on both a PA and GAA basis. WISPA has proposed a licensing approach that balances the needs of consumers in rural areas with the desire for small cells in non-rural areas. By incorporating spectrum use variables and dynamic frequency assignment protocols, the SAS would protect Incumbent Access and Priority Access users from harmful interference, coordinate spectrum use between access tiers and within access tiers, differentiate between rural and non-rural areas and account for differences in power and other technical characteristics to promote co-existence among disparate users.

The Call for Papers divides the technical discussion into the following four main Focus Areas, each with several topics.

- (A) - General Responsibilities and Composition of SAS
- (B) – SAS Functional Requirements
- (C) – SAS Monitoring and Management of Spectrum Use
- (D) – Issues Related to Launch and Evolution of SAS and Band Planning

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[1] *Public Notice*, "Wireless Telecommunications Bureau and Office of Engineering and Technology Call for Papers on the Proposed Spectrum Access System for the 3.5 GHz Band, DA 13-2213 (Nov. 18, 2013).

WISPA addresses only those topics where we believe we can offer specific expertise. We intentionally do not address those areas where we believe others will offer their own specialized expertise. Some topics may be discussed or touched upon in more than one Focus Area.

Focus Area A.1. Scope of SAS Responsibilities for Enabling and De-conflicting Use of the 3.5 GHz Band

(See also related discussions under topics B.1., B.2., B.4., B.5., C.1., and C.2.)

The SAS can automatically enable and de-conflict use of the band if it has the capability to (a) dynamically assign non-conflicting operating frequencies, (b) detect instances of actual interference, and (c) automatically re-assign (one or, if necessary, both) operating frequencies to resolve the interference. To implement this functionality, the SAS must include the following capabilities:

1. Know the geographic location of each network node. This requirement can be met by requiring each base station (BS) or access point (AP) to be GPS-enabled and to report its GPS coordinates to the SAS.

2. Be "census-tract aware". This requirement can be met by incorporating a census tract map overlay into the SAS.

3. Be "terrain aware." This requirement can be met by incorporating a terrain database into the SAS.

4. Be "obstruction aware." This requirement can be met by incorporating an obstruction database into the SAS and updating it at regular intervals. NOTE: A simpler but possibly sufficient option would be to use an Irregular Terrain Model (Longley-Rice Model) to predict a line-of-sight (LOS) contour without tree loss, thereby providing a coverage "buffer." Public domain source code is available at < http://www.its.bldrdoc.gov/resources/radio-propagation-software/itm/itm.aspx>.

5. Know the conducted power level and the channel width of each BS or AP at installation time. This requirement can be met by (a) automatically polling each new BS or AP transmitter, or (b) automatically "pushing" the data from each transmitter to the SAS database.

6. Know the antenna characteristics of each BS or AP transmitter antenna system (gain, polarization, horizontal and vertical beamwidth, HAAT, downtilt, etc.) at installation time. This requirement can be met (a) by each federal incumbent, licensee or technical contact person (in the case of a GAA operator) manually entering the antenna data into the SAS prior to full node activation, or (b) in the case of a low-power, integrated, certified transmitter with a permanently-attached antenna used indoors or at ground level, automatically pushing the antenna information to the SAS.

7. Know the receiver threshold level for each BS or AP receiver at the lowest modulation rate. This requirement can be met by (a) each licensee or technical contact person manually entering the data into the SAS prior to full node activation, or (b) automatically pushing the data to the SAS.

8. Know the coverage area (or contour) of each BS or AP transmitter. This requirement can be met by using the known transmitter and antenna system data and the known terrain and obstruction data to calculate the coverage area (or contour).

9. Assign non-conflicting operating frequencies (or channels) to each transmitter or network node. This requirement can be met by taking each coverage area (or contour) into account and selecting frequencies with coverage areas (or contours) that do not significantly overlap.

Focus Area A.4. Interoperability

Interoperability between multiple SAS vendors can be ensured using the same methods used to ensure interoperability between the multiple TVWS database vendors. These procedures and interfaces were developed by the tentatively selected database administrators and approved by the FCC. Interoperability between multiple SASs and Authorized Users (AUs) can be ensured by requiring the use of a common AU interface for all SASs and all AUs. WISPA recommends that the same common development approach be adopted in this proceeding.

Focus Area B.1. Minimum Set of Information (SAS-AU)

The minimum set of information from SAS to AU must include the authorized operating frequency.

The minimum set of information from AU to SAS must include the following:

1. Geographic location (GPS lat/long, census tract)
2. User class (Incumbent Access, Priority Access and General Authorized Access)
3. AU make, model and unique ID
4. Unique identifying information for each Priority Access licensee
5. Unique identifying information for each GAA AP operator
6. Transmitter conducted power level
7. Channel width
8. Net antenna system gain
9. Antenna azimuth
10. Antenna polarization
11. Antenna horizontal and vertical beamwidth
12. Antenna HAAT
13. Antenna downtilt
14. AU technical contact person name and email address

Focus Area B.2. Required SAS Obligations

Required SAS obligations should include the following:

1. Initial AU frequency assignments
2. AU frequency change commands
3. Requests for AU management database or system administration statistical information

4. AU standby commands
5. Allowing authorized PA and GAA technical personnel to opt-in or sign up for access to an SAS history log describing technical information about the operation (for example, frequency changes) of their AU
6. Emailed requests to AU technical contact person to make contact

Focus Area B.4. Required AU-Supplied Information

The AU must supply the SAS with all the information included in the discussion regarding Focus Area B.2. (above) plus the following:

1. Operating frequency (or frequency change) confirmation
2. Transmitter conducted power (change) confirmation
3. Receiver threshold level at the lowest modulation rate
4. Uptime since last reset of management or system administration database statistics
5. Packet or frame retransmission percentage
6. Traffic level as indicated by the aggregate number of packets sent and received
7. Number of currently-connected client devices
8. Operating status (active, standby, booting up, shutting down)

Focus Area B.5. Updates

Updates from SAS to AUs or other network devices should be pushed out to the AUs as soon as they are available. Frequency change commands should also be pushed to AU(s) as soon as they are available.

Updates from AUs to SAS should be sent whenever an AU is polled by the SAS. To fulfill its network monitoring, logging and decision-making capabilities, the SAS will probably need to request AU management or system administration database information at regular intervals. Initially, sixty-minute intervals are suggested.

Focus Area B.7. SAS Updates

Information updates among SAS systems from different vendors could be handled using the same techniques used by the multiple TVWS databases.

Focus Area C.1. AU Spectrum Usage Determination

The relative success of the SAS depends on its ability to account for all four dimensions of spectrum – time, frequency, geography and power – and to dynamically assign (or re-assign) frequencies on the basis of these dimensions within and between the three spectrum access tiers. To maximize spectral efficiency and use spectrum to its fullest potential, frequencies should not be permanently and exclusively assigned. The SAS can act to detect whenever a specific frequency (PA or GAA) has not been and is not currently in actual use and reassign that specific frequency within a specific area (census tract) to another user who has a current need to communicate. This is somewhat analogous to VHF and UHF

trunked radio systems where rather than have each user group (for example, the police department, fire department or water department) permanently and exclusively assigned to a specific frequency whether they are currently using it or not, all the available frequencies (for example, for an entire city) are used as a common frequency pool. When any user, irrespective of user group, wishes to transmit, the control station (or "site controller") automatically assigns that user and all other users in that user group to an available, clear frequency from the common frequency pool. By pooling frequencies and dynamically assigning frequencies from within the pool, spectral efficiency is maximized. A trunked system can accommodate more users with a smaller common pool of frequencies compared to an untrunked (exclusive frequency) system. Of course, key to this functionality is knowing which frequencies are actually in use and which are available at any point in time.

The management or system administration database of virtually all modern wireless equipment collects statistics about traffic levels such as the number of packets exchanged and the number of connected client devices. By regularly and automatically polling AUs, the SAS can pull, log, monitor and report this usage data in near real time. By setting reasonable decision-criteria thresholds in the SAS, the SAS can differentiate between BSs or APs that are handling actual, real-world customer traffic and which BSs or APs are simply "idling" and not serving real, end-user needs. The object here is to prevent "gaming" the system, through the use of so-called "frequency-savers" designed to give the appearance that a BS or AP is in real-world use while it is in fact not actually serving end-users.

Focus Area C.2. Measuring and Mitigating Inter-AU Interference

The SAS can automatically detect and mitigate interference by reassigning operating frequencies. WISPA recommends the following process to determine when AUs are interfering with each other:

1. At practical but regular intervals, the SAS polls each BS or AP to obtain the effective error rate. It logs and monitors this data. BS or AP transmitter **packet or frame retransmission percentage data** serves as an indicator of the effective error rate because packets are retransmitted only when there is no acknowledgement received from the first (or a subsequent) packet transmission attempt. The self-contained management or system administration database of virtually all modern wireless equipment logs and retains this retransmit data. For properly operating systems, error rates (retransmission percentages) of one-to-two percent are fairly typical while an error rate of ten percent could be considered abnormally high.

2. When the SAS detects that the error rates of adjacent (or nearby) BS or AP transmitters have simultaneously increased in the same time frame, it typically indicates that mutual interference is occurring between the two networks. This method should work even when/if the air interfaces between the two networks are different. Retransmission rates can also simultaneously increase for other reasons not necessarily related to mutual interference between the networks. For example, retransmission rates can increase due to transmitter, receiver or antenna system failures however, when this happens there will not be a simultaneous increase in retransmission rates in adjacent or nearby transmitters on different networks. WISPA believes that in 95 percent of the cases of a simultaneous, mutually-occurring increase in retransmission rates that the cause will be due to actual mutual interference

between the affected transmitters. In the other 5 percent of the cases, the cause will be attributed to other environmental factors such as (a) the presence of a series of accidental or intentional transmissions from a non-SAS-coordinated transmitter, or (b) an area-wide power interruption, or c) some other region-wide environmental factors. In these "5 percent" cases, the SAS can not be expected to be able to mitigate the interference by reassigning frequencies.

3. When the SAS detects mutually-rising error rates for adjacent equipment, it re-assigns one of the AUs to change to a different, non-interfering frequency.

4. If optionally selected by an AU technical contact person, the SAS could email the contact person a "frequency change complete" notice, including the new frequency information for the AU(s).

Focus Area C.3. Enforcement Mechanisms

The SAS could also be used to disallow (or fail to authorize) the operation of any unauthorized or uncertified transmitters in the 3550-3650 MHz frequency range. To promote this end, it will be necessary to ensure that FCC equipment certification procedures effectively support the requirement that new equipment be designed and tested to standards that disallow software tampering designed to defeat SAS operation and control.

Focus Area D.1. Deployment Functions

A phase-in of SAS technical functionality will likely prove helpful for all parties. One such example may be initially limiting allowable antenna parameters (discussed in Focus Area A.1.) to omnidirectional, 120-degree and 180-degree patterns. As successful SAS-mediated operation is demonstrated, additional antenna patterns can be added.

Conclusion

WISPA is pleased to have the opportunity to contribute to the development of what we believe is a new era in intelligent spectrum management. As noted in the PCAST report, spectrum is an important national resource whose use must be made more valuable by allowing it to be used more efficiently. WISPA looks forward to continuing to dialogue with other industry stakeholders to assure the development of a dynamic, robust and effective Spectrum Access System.

Respectfully Submitted,

/s/ Jack Unger

WISPA Technical Consultant